Chapter

8 PRACTICALS

PRACTICAL NO.1

AIM : *Study of construction detail of CNC lathe.*

Theory : A computer numerical control (CNC) is a microprocessor based system to store and process the data for the control of slide motions and auxiliary function of the machine tools. The CNC system is the heart and brain of a CNC machine. Which enables the operation of the various machine members such as slides, spindles etc. as per the sequence programmed into it, depending on the machining operation. The CNC systems are constructed with NC unit integrate with programmable logic controller (PLC) and sometimes with an additional external PLC (non integrated).

Construction Detail of CNC : The constructional detail of CNC are as follows :

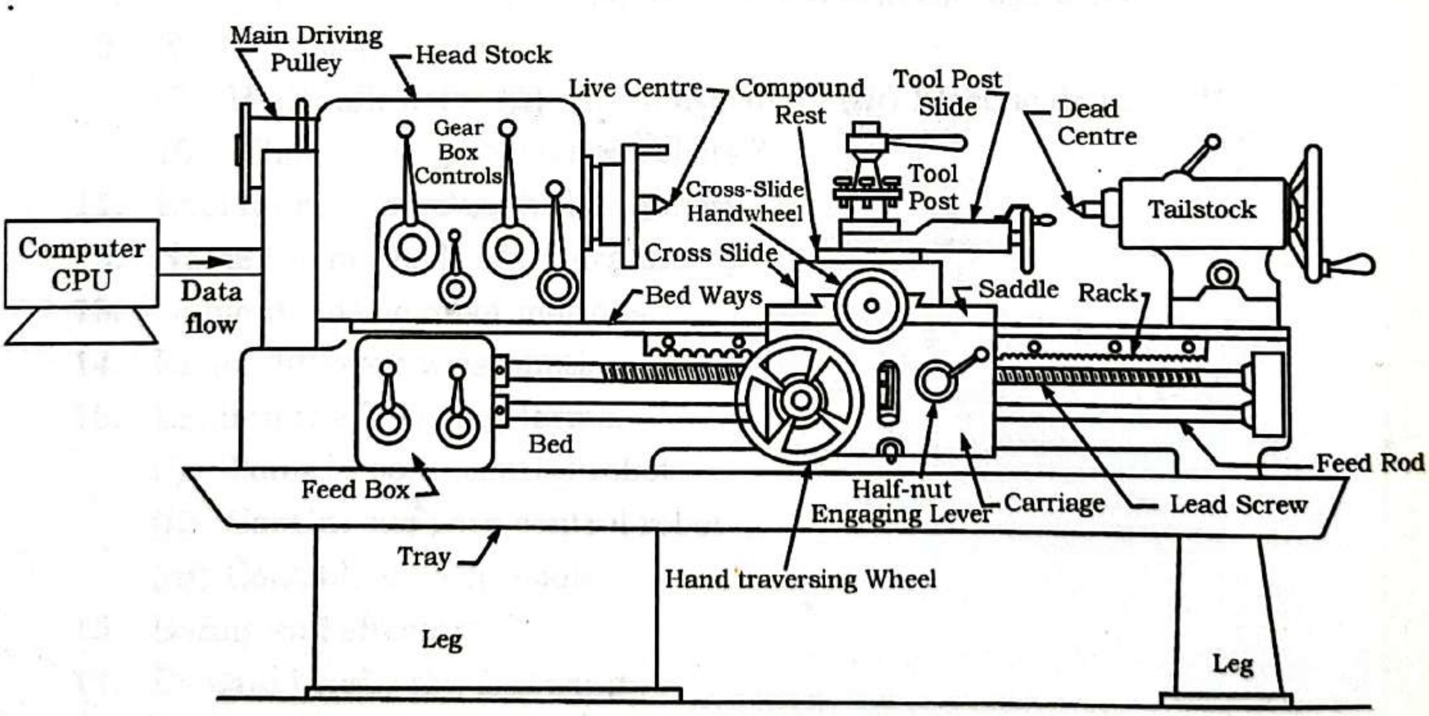


Fig. P-1.1(*a*) : Centre Lathe

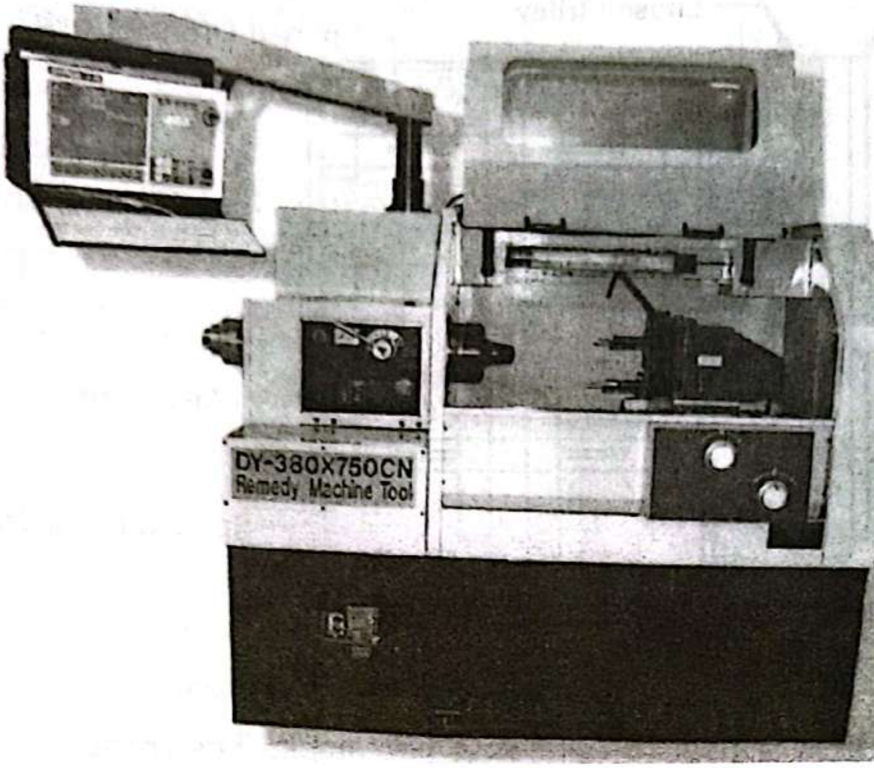
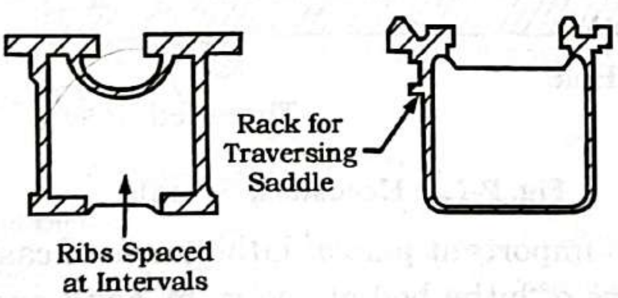


Fig. P-1(*b*)

1. Bed : This bed is the base or foundation of the lathe. It is a heavy and rigid casting made in one piece to resist deflection and vibrations. It holds or supports all other parts, that is head stock, tailstock and carriage etc. On the top of the bed, there are two sets of guide of guide ways-outer ways and innerways. Outerways is for the carriage and the innerways for the tailstock. Two types of bed is shown in fig. P-1.2 (*a*), (*b*).



(*a*) Flat Guides (*b*) Flat and Inverted Vee Guides

Fig. P-1.2 : Bed

2. Headstock : The headstock assembly is permanently fastened to the left hand end of the lathe. It serves to support the spindle and driving arrangements. The spindle revolves in bearings, one at each end of the headstock. The spindle is rotated by a combination of gears and cone pulleys or by gears alone. The modern lathes are provided with all-geared type headstock to get large variation of spindle speeds. Fig. P-1.3 shows a 9-speed all-geared headstock.

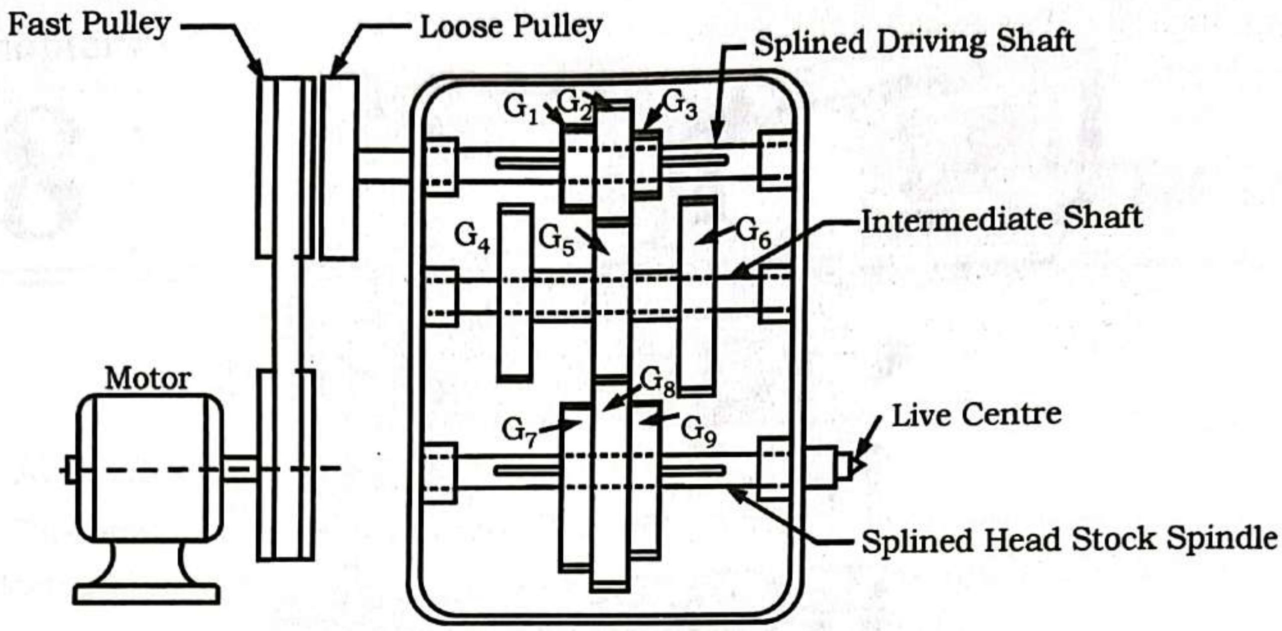


Fig. P-1.3 : 9-Speed All-geared Headstock

The steel spindle is hollow to take long bar stock. The front end of the hole is tapered for holding centres and other tools having a standard morse tapered shank. A tapered sleeve fits into the tapered spindle hole. The nose of spindle may be of flanged type or threaded, but the later type is mostly used on lathes.

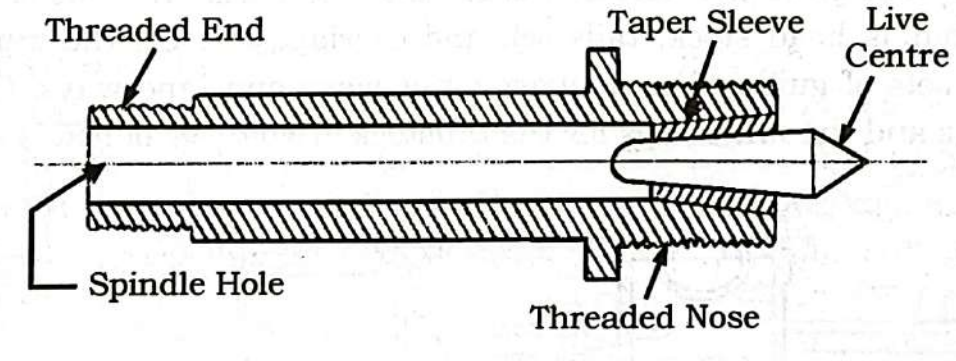


Fig. P-1.4 : Headstock Spindle

3. Tailstock : It is an important part of lathe made of cast iron or mild steel. It is located on the innerways of lathe bed at the right hand end of the bed. This has the following main uses :

(*a*) It helps in performing taper turning operation.

(*b*) It holds a tool performing operations such as reaming, drilling, tapping etc.

(*c*) It support the other end of the work when it is being machined between centres.

A tailstock is illustrated in fig. P-1.5.

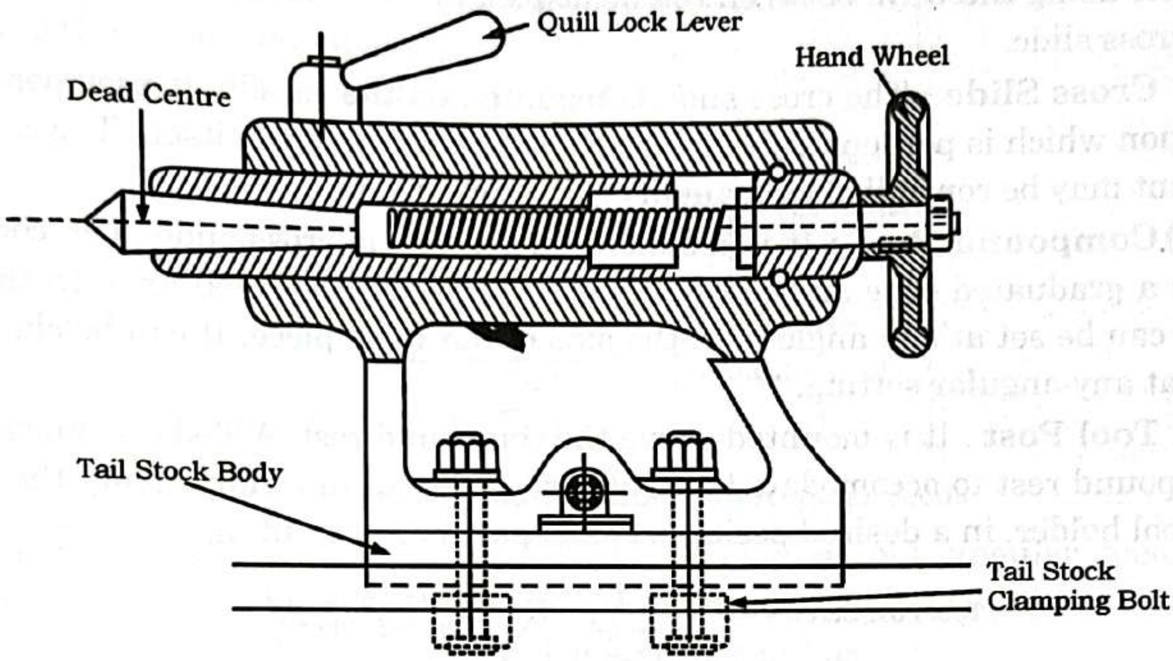


Fig. 1.5 : Tailstock

The tailstock spindle is a hollow tapered shaft (left side end). It cab be used to hold the dead centre or other tools having the same tapers such as drills and reamers. The tailstock hand wheel is used to move the tailstock spindle in or out of the tailstock casting and a spindle clamping lever or lock handle is used to hold the tailstock spindle in a fixed position.

4. Carriage : It is placed between the headstock and the tailstock. It controls and supports the cutting tool. It is movable on the bed ways and its purpose is to hold the cutting tool and to impart to it either longitudinal or cross feed. It has five major parts (Ref. Fig. P-1.6).

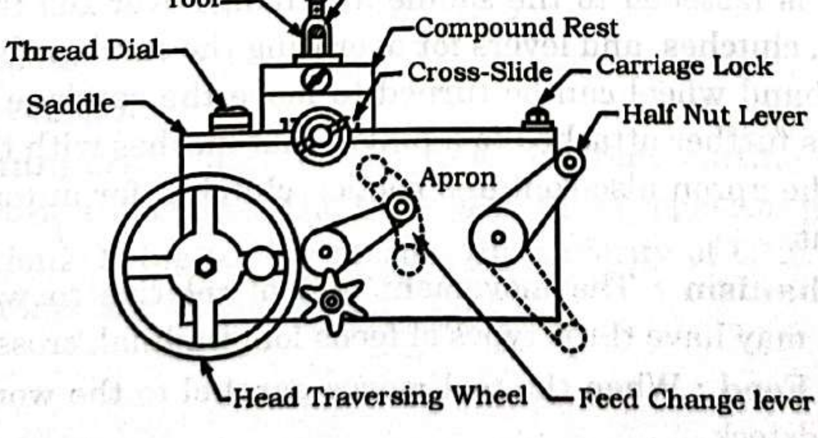


Fig. P-1.6 : Carriage

(i) **Saddle :** Saddle is a H shaped casting mounted on the top of the lathe ways so it slides along the ways between the headstock and tailstock. It severs as the base for the cross slide.

(ii) **Cross Slide :** The cross slide is mounted on the saddle. It provides cutting tool motion which is perpendicular to the cente line of the lathe itself. The cross feed movement may be controlled by manual or by power feed.

(iii).**Compound Rest :** It is mounted on top of the cross-slide. The compound rest has a graduated base and can be swivelled around a vertical axis. In this way, its slide can be set at any angle with the axis of the work piece. It can be clamped to remain at any angular setting.

(iv) **Tool Post :** It is mounted above the compound rest. A T-slot is machined in the compound rest to accomodate the tool post. It serves to rigidly clamp the cutting tool or tool holder, in a desired position. A tool part is shown in fig. P-1.7.

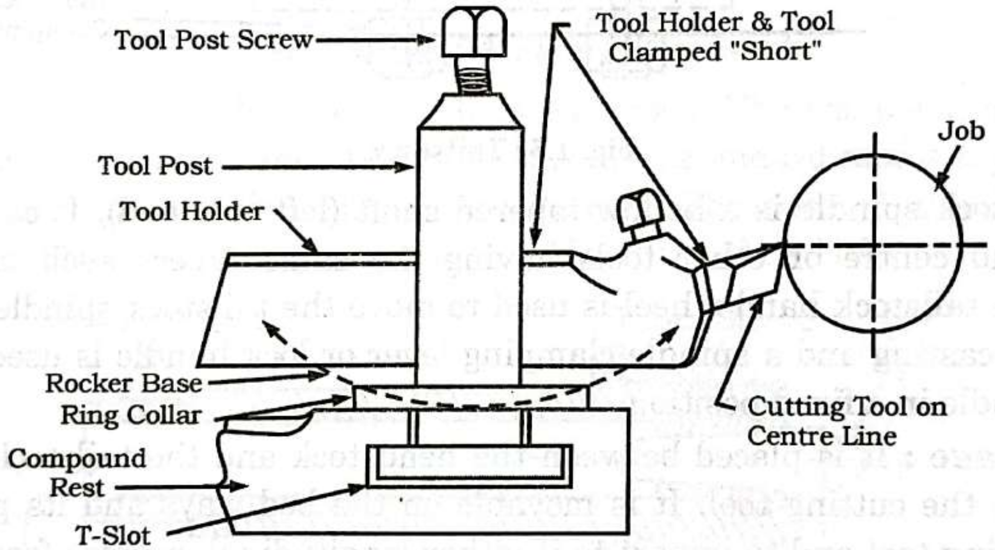


Fig. P-1.7 : Tool Post

(v) **Apron :** It is fastened to the saddle and hangs over the front of the bed. It contains the gears, clutches, and levers for operating the carriage by hand and power feeds. The apron hand wheel can be turned to move the carriage longitudinally by hand. This wheel is further attached to a pinion that meshes with the rack under the front of the fed. The apron also contains friction clutches for automatic feeds and a split nut or half nut.

5. Feed Mechanism : The movement of tool relative to work is termed as "feed". A lathe tool may have three types of feeds longitudinal, cross and angular.

Longitudinal Feed : When the tool moves parallel to the work *i.e.*, towards or away from the headstock.

Cross feed : When the tool moves perpendicular to the work *i.e.*, towards or away from the operator.

Angular feed : When the tool moves at an angle to the work. It is obtained by swivelling the compound slide.

The three types of feed is shown in fig. P-1.8.

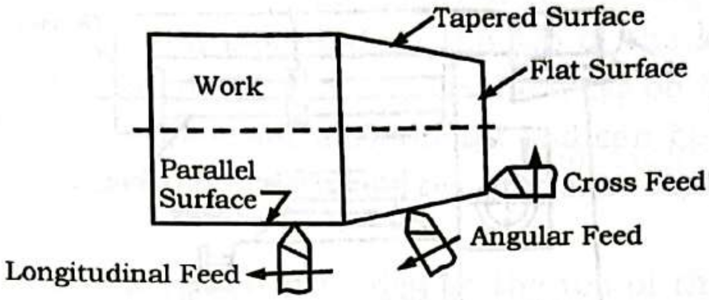


Fig. P-1.8 : Longitudinal Cross and Angular Feeds

Both cross-feed and longitudinal feed are manual but angular feed can be automated. The other parts of feed mechanism are :

(*a*) End of bed gearing (*b*) Feed gear box

(*c*) Feed rod and lead screw (*d*) Apron mechanism.

6. **Computer :** The CNC machine controlled by the computer which reads the program and translates it into machine language, which is a programming language of binary notation used on computers. When the operator starts the execution cycle the computer translates the binary codes in electronic pulses which are automatically sent to the machine's power units.

7. **Drive Motors :** When the motor receives each pulses, they automatically transform the pulses into rotations that drive the spindle and lead screw, causing the spindle to rotate and slide or move the table. The drive motors are classified into four basic types

(*i*) A.C. servomotor

(*ii*) D.C. servo motor

(*iii*) Stepper motor

(*iv*) Fluid servomotor.

8. **Tool Changers :** Most of the time different cutting tools are used to produced one part of a machine. The tools have to be replaced quickly for the next machining operation. Owing to this reason, the majority of CNC machine tools are equipped with automatic tool changers.

PRACTICAL NO. 2

AIM : ***Study of constructional details detail of CNC milling machine.***

Theory : A description of the principle parts of a milling machine as follows :

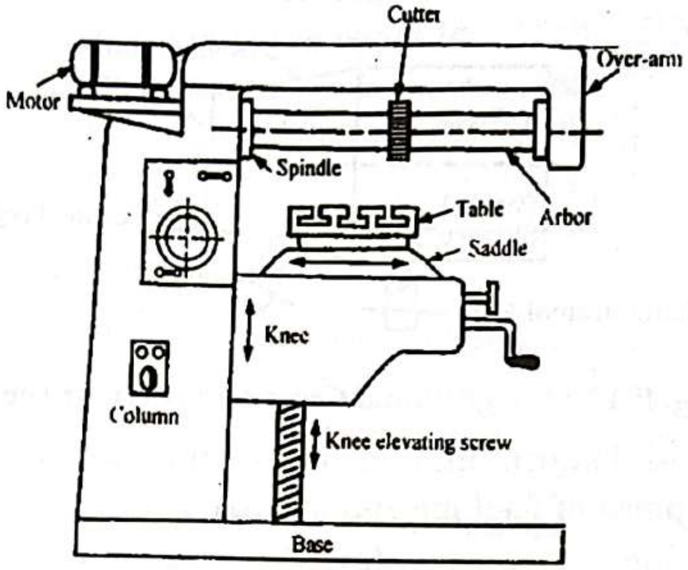


Fig. P-2.1(*a*) Schematic Diagram of a Milling Machine

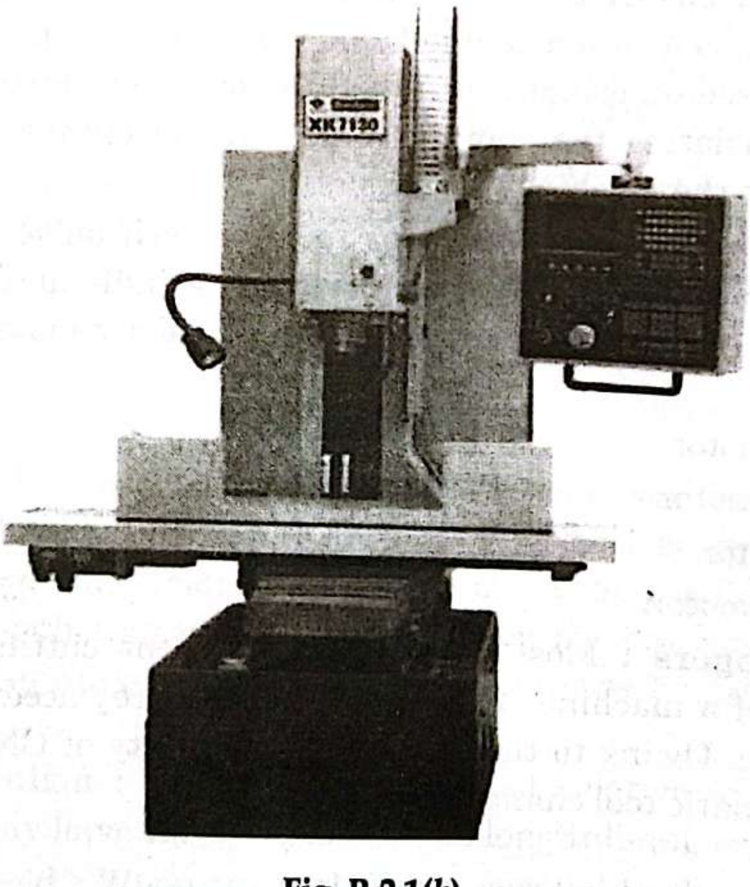


Fig. P-2.1(*b*)

***(i)* Base :** It is a heavy casting which supports all parts of the machine and is accurately machined on both the sides of the base surface.

***(ii)* Column :** The main casting of a milling machine is known as the column. It encloses and supports all the parts of the milling machine.

***(iii)* Knee :** It is a unit attached in front of the column. It moves up and down on the slide ways and encloses the feed change gearing mechanism.

***(iv)* Saddle :** It is a casting mounted on the top of the knee. It supports and carries the table. It is adjustable transversely on the ways on the top of the knee. It is provided with graduations for exact movements and can be operated by hand or power. The saddle of the machine is made in two parts, so that table can be rotated horizontally.

***(v)* Table :** It is an attachment provided at the top of the knee. It is used for holding the workpiece for machining and can be moved in a longitudinal as well as in a crosswise direction.

***(vi)* Spindle :** It is a large shaft located at the top of the column having a tapered hole infront of it. The tapered hole is used for holding arbors and cutting tools.

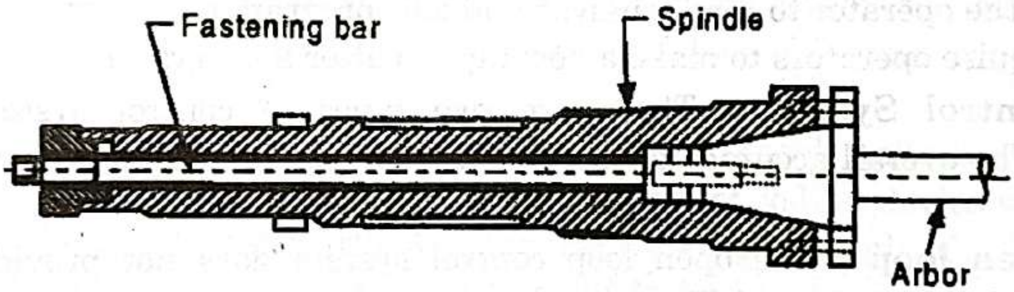
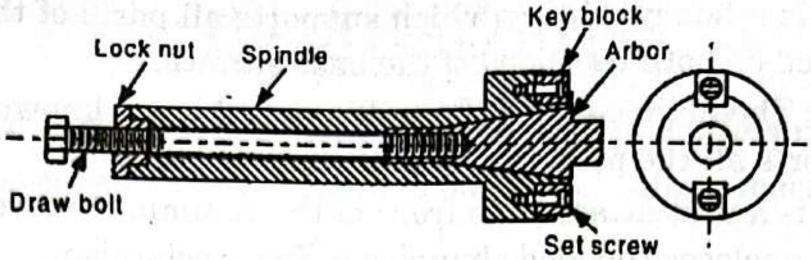


Fig. P-2.2 : Milling machine spindle

***(vii)* Overarm :** The portion at the top of the column above the spindle is called the overarm. It is used for supporting arbors and can be moved forward and backward.

***(viii)* Arbor :** The arbor is an accurately machined shaft for holding and driving the arbor type cutter. It is tapered at one end to fit the spindle nose and has two slots to fit the nose keys for locating and driving it. The use of very thin shims made to position the cutter precisely.



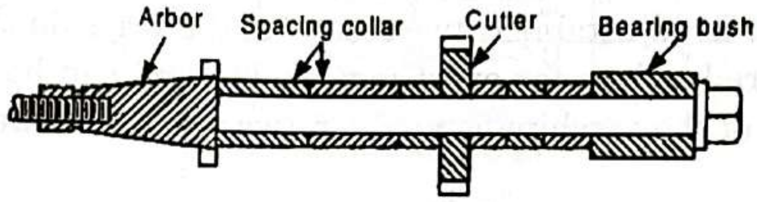


Fig. P-2.3 : Arbor assembly

(ix) Computer : CNC machines introduced in the late 1970,s were less dependent on hardware and more dependent on software. These machines store a program into memory when it is first read in. This facilitates faster operation when producing number of identical parts. Since the program can be recalled from memory repeatedly without having to read it again. CNC machines use an on-board computer that allows the operator to read, analyze and edit programmed instruction, while NC machine require operators to make a new tape to alter a programme.

(x) Control System : There are two types of control systems in CNC machines. The overall accuracy of the machine is determined by the type of control loop used.

(a) Open loop : The open loop control system does not provide positining feedback to the control unit. The movement pulses are sent out by the control unit and are received by a special type of servomotor.

(b) Closed loop : In the closed loop control system, the electronic movement pulses are sent from the control to the servomotor enabling the motor to rotate with each pulse. The pulses are detected and canted by a feedback device called a transducer with each step of movement. A transducer sends a signal back to the control which compares the current position of the driven axis with the programmed position.

(xi) Drive : As in case on CNC lathe the CNC milling also have form types of drive motor control.

(a) Stepper motor

(b) DC servomotor

(c) A.C servomotor

(d) Fluid servomotor

PRACTICAL NO. 3

AIM : ***Study the constructional detail and working of automatic tool changer and multiple pallets.***

Theory : The machining center or turning centre in CNC equipment often requires more than one tool to complete the process. These tools are hold in the tool magazine, from where they can be picked, used and are placed back after use in an operation. These tools are changed and are set quite regularly in between the process and hence must be done at a fast speed. The time spent to change these tools (idle time) must be minimized. For this a device known as automatic tool changer (ATC) is used.

(*a*) CONSTRUCTIONAL DETAIL AND WORKING OF ATC : The CNC machines are designed to perform a number of operations in a single setting of the job. A number of tools may be required for making a complex part. In a manual machine, the tools are changed manually whenever required. In a CNC machine, tools are changed through program instructions. The tool are fitted in a **tool magazine** or drum. When a tool needs to be changed, the drum rotates to an empty position approaches the old tool and pull it. Then it again rotates to position the new tool, fits it and then retracts. This is a typical tool changing sequence of an automatic tool changer (ATC).

ATC take approximately 3 to 7, seconds time during tool change operation. This requires that each tool can be identify by some form of coding device which can be recognised by the tool transfer arm. The general working principle of a ATC employs a **tool transfer arm** which is used to select the desired tool automatically from the magazine and replace it with a new tool which is already exists in the machine spindle. (Fig. P- 3.1 (*a*) (*b*)).

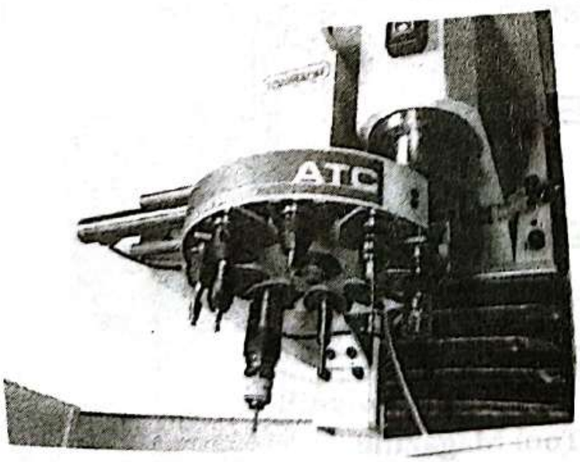


Fig. 3.1(*a*)

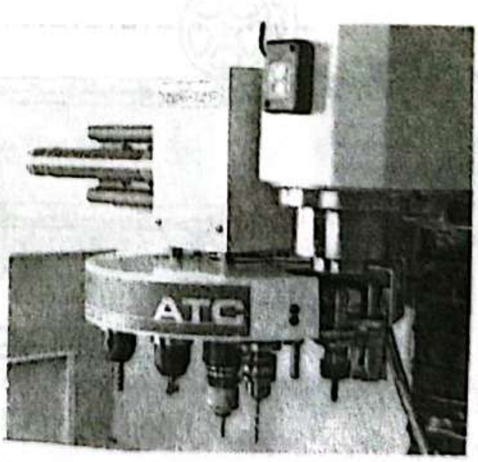


Fig. 3.1(*b*)

Types of tool Magazines : Tool magazines are classified into three types :

***(i)* Turret type :** This is the simplest type of tool magazine as shown in fig. P-3.2. In this type tool storage and changing produce is combined.

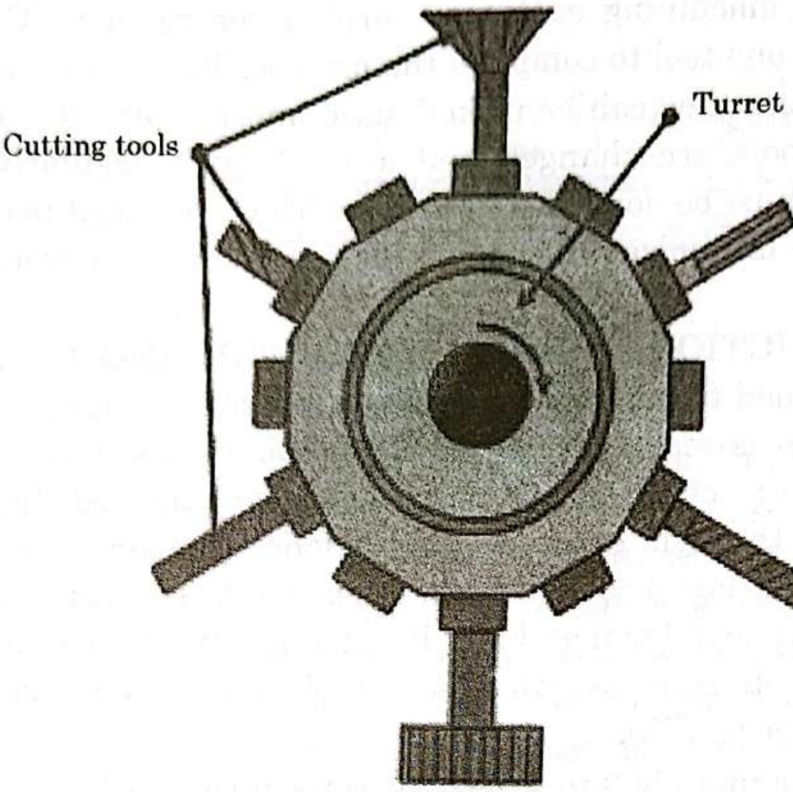


Fig. P-3.2

***(ii)* Chain type :** When the number of tools seared in magazine are more then chain type tool magazine and used. A chain type tool magazine is shown in fig.P-3.3.

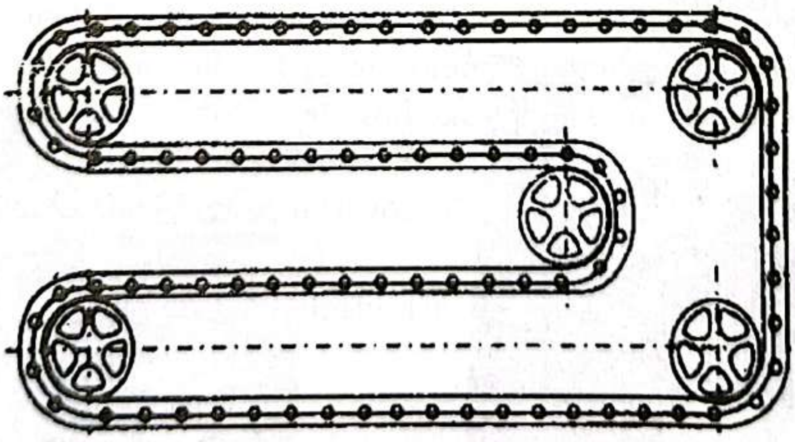


Fig. P-3.3 : Chain Type Tool Magazine

***(iii)* Drum type :** This type of tool magazine found in most of CNC machine tools. In this a typical drum rotates for the purpose of tool change. (Fig. P-3.4).

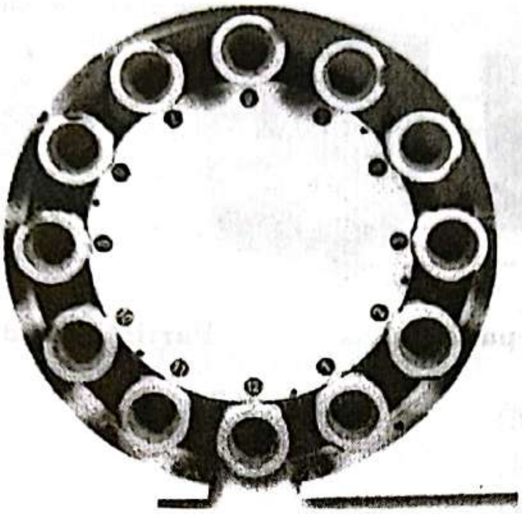
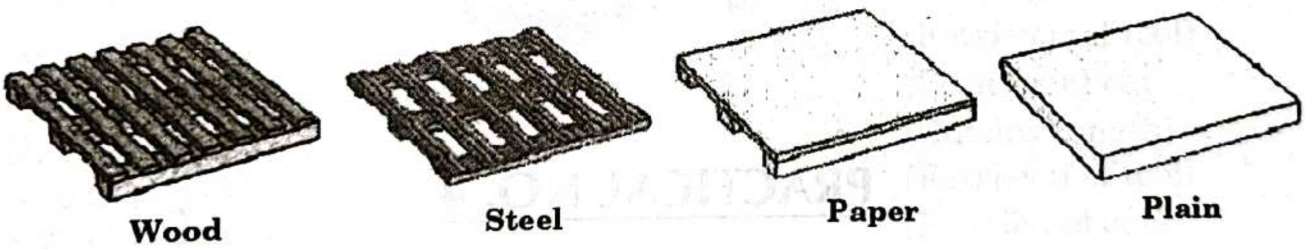


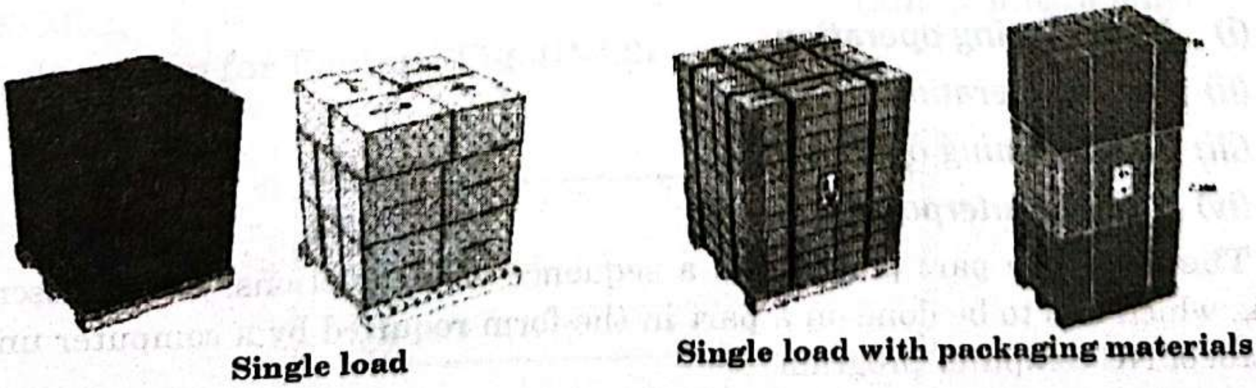
Fig. P-3.4

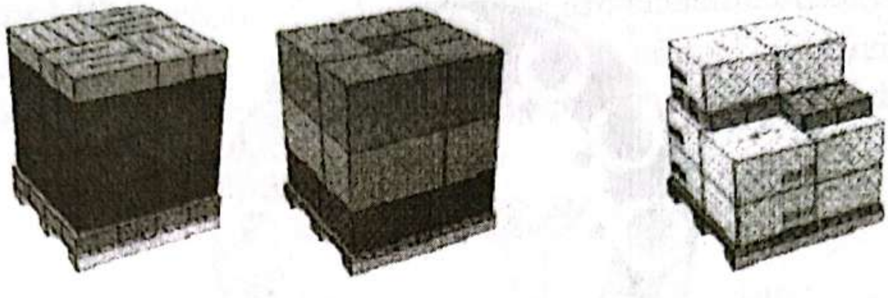
***(b)* MULTIPLE PALLETS** : Multiple pallets are work holders, that are designed for transported by the material handling system. The parts are hold on upper face of pallet and lower face of pallet is designed to be moved, located and clamped in position at work table of the machine. The designed of the multiple pallet is depend on the geometry of the workpiece and nature of the operations. Some common type of multiple pallets are shown in fig. P-3.5.

Supports Rich Pallet Types :



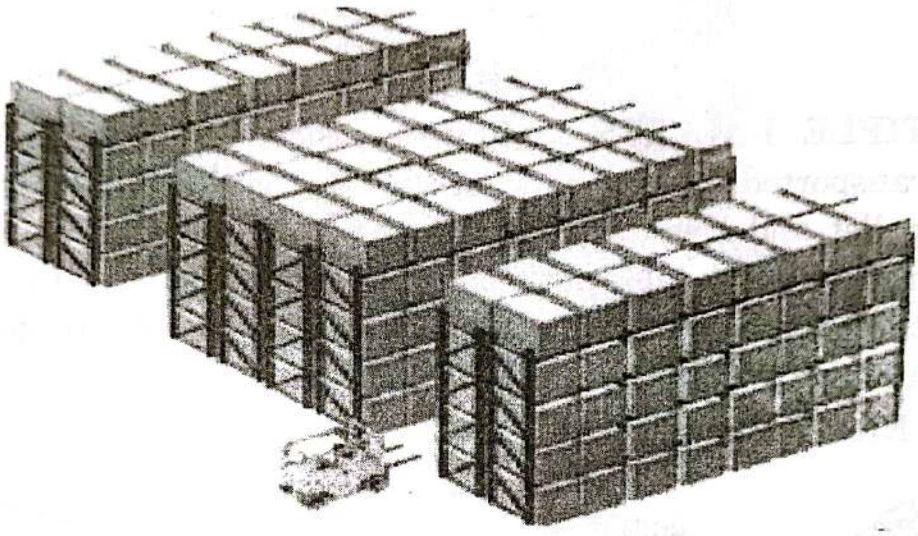
Single and Mixed Pallet Loads :





Mixed pallet loads Partial mixed pallet loads

Fig. P-3.5



PRACTICAL NO. 4

AIM : ***Develop a part programme for following lathe operations and make the job on CNC lathe :***

(i) Plain turning operation

(ii) Facing operation

(iii) Taper turning operation

(iv) Circular interpolation

Theory : The part program is a sequence of instructions, which describe the work, which has to be done on a part in the form required by a computer under the control of NC computer program.

(*i*) Part Program Plain Turning :

01(All dimensions are in mm). Fig. P-4.1.

01 (All dimensions are in mm).

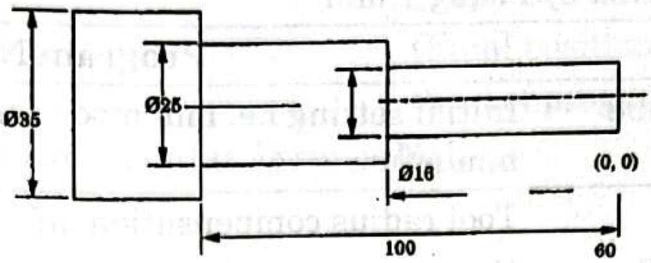


Fig. P-4.1 : Turning Operation

```
% 1000;                                 (Main programme)
N01 G54 G90 G71 G94 M03 S800;           (Parameters Setting)
N05 G01 X-12.5 Z0 F2;                   (Facing the job)
N10 G00 Z1;                             (Retrieval of tool)
N15 G00 X00;                            (Tool clearance)
N20 G01 Z-100;                          (Starting cut)
N25 G00 X1V Z1;                         (Clearance position)
N30 G00 X-2;                            (Position of cut)
N35 G01 Z-60;                           (Cutting length)
N40 G00 X-1 Z1;                         (Retrieval of tool)
N45 G00 X-3;                            (Position of cut)
N50 G01 Z-60;                           (Cutting length)
N55 G00 X-2 Z1;                         (Retrieval of tool)
N60 G00 X-4;                            (Position of cut)
N65 G01 Z-60;                           (Cutting length)
N70 G00 X-3 Z1;                         (Retrieval of tool)
N75 G00 X-4.5;                          (Position of cut)
N80 G01 Z-60;                           (Cutting length)
N85 G00 X5 Z5;                          (Final position of tool)
N90 M02;                                (End of programme)
```

(*ii*) Program for Facing : Fig. (P-4.2)

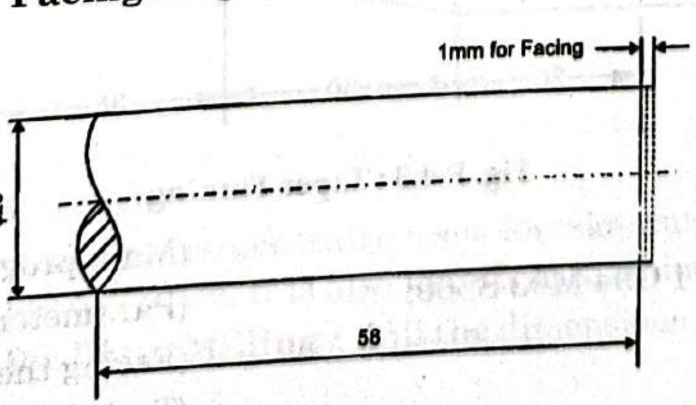


Fig. P-4.2 : Facing Operation

Material Removed by facing 1 mm

O 1002	Program Number
N010 G21 G97 G98	Initial setting i.e. mm mode constant RPM, and feed in mm/min
N020 G40	Tool radius compensation off
N030 G28 U0 W0	Go to home position
N040 M06 T06	Tool No. 6 is selected
N050 M03 S 1500	Spindle speed is 1500 RPM
N060 G00 X30.0 Z1.0	Tool moving rapidly from Home position to X30; Z1.0
N070 G01 Z-10 F50	Depth of cut 1 mm at a feed rate of 50 mm/min
N080 G01 X0.0	Tool is moving towards centre of job
N090 G01 Z1.0	Tool is moving 1 mm way from job face
N100 G00 X30.0	Tool is moving rapidly at X30.0 and Z1.0
N110 G28 U0 W0	Go to Home position
N120 M05	Stop the spindle
N130 M30	Program stop and rewind

***(iii)* Programme for taper turning**

Example

03 (All dimensions are in mm). Fig. P-4.3

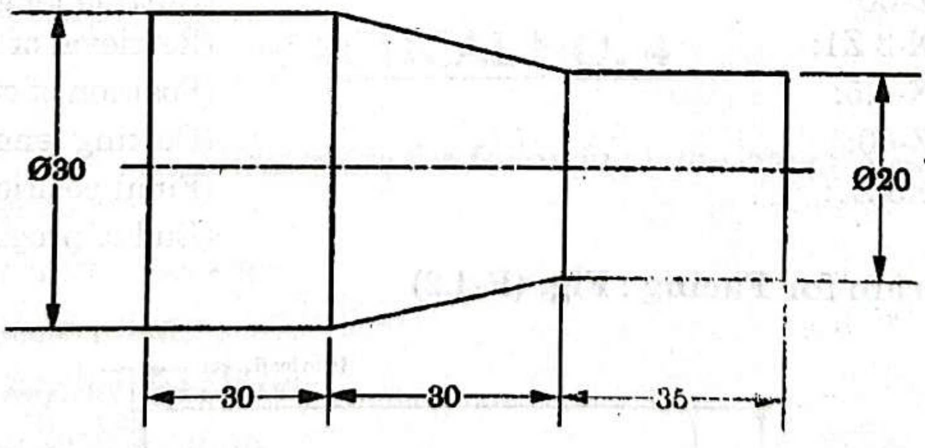


Fig. P-4.3 : Taper Turning

% 2000;	(Main programme)
N01 G54 G91 G71 G94 M03 S800;	(Parameters Setting)
N10 G00 Z1;	(Facing the job)
N15 G00 X10;	(Tool clearance)
N20 G01 Z-36;	(Tool clearance from the centre)

N25 G01 X5 –Z30; (Taper turning operation)
N30 G00 X1 Z66; (Final position of tool)
N35 M02; (End of programme)

(iv) Part Programme for circular Interpolation

Example

04 (All dimensions are in mm).

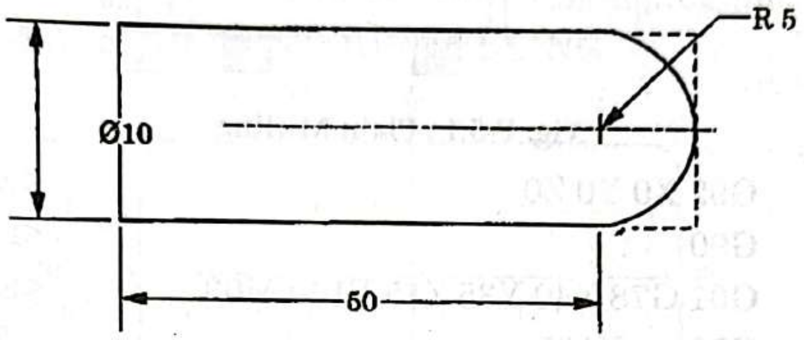


Fig. P-4.4 : Circular Interpolation

%2000; (Main programme)
N01 G91 G71 G94 M03 S800; (Parameters Setting)
N05 G01 X-5 Z0 F1; (Facing the job)
N10 G02 X5 Z-5 10 K5; (Circular Interpolation)
N15 G00 X6 Z6; (Final position of tool)
N20 M02; (End of programme).

PRACTICAL NO. 5

AIM : ***Develop part progarmme for the following milling operation and make job on CNC milling.***

(i) Plain milling

(ii) Slot milling

(iii) Contouring

(iv) Pocket milling.

Theory : Milling machine is generally used for slot cutting, contouring and pocket milling etc. on the workpiece. It is also known as machine centre.

(i) Programme for Plain Milling : (All the dimensions are in mm).

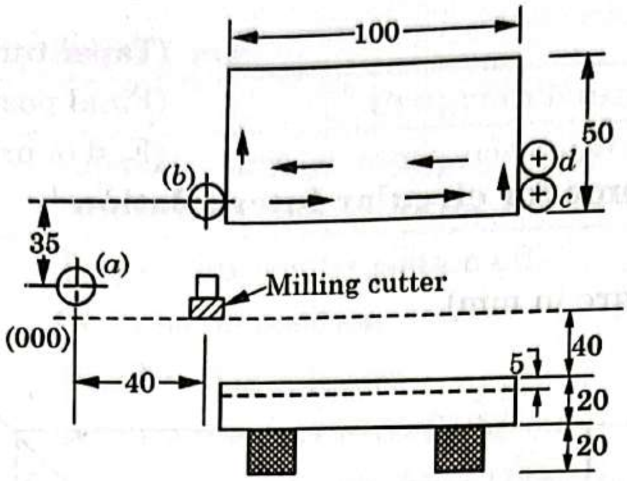


Fig. P-5.1 : Plain Milling

```
N01    G92 X0 Y0 Z0                    <EOB>
N02    G90                             <EOB>
N03    G01 G78 X40 Y35 Z45 F100 M03    <EOB>
N04    G79    X165                     <EOB>
N05    G78    X50                      <EOB>
N06    G79    X40                      <EOB>
N07    G78    X65                      <EOB>
N08    G79    X165                     <EOB>
N09    G78    Y80                      <EOB>
N10    G79    Y40                      <EOB>
N11    G80    Z0 F0 M05                <EOB>
N12                  X0 Y0 Z0          <EOB>
N13                  M02               <EOB>
```

***(ii)* Programme for slot cutting :**

(All dimension are in mm).

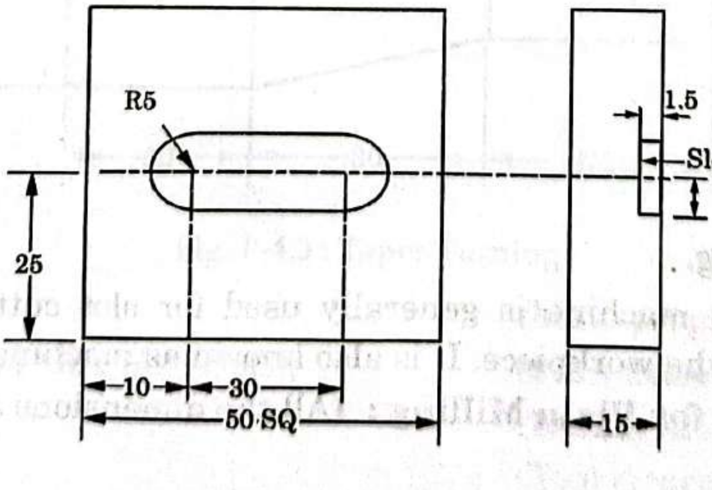


Fig. P-5.2 : Slot Cutting

% 100;	(Main programme)
N5 G17 G71 G90 G94 G54;	(Parameters Setting)
N10 T2 L90;	(Home position)
N15 G00 D2 Z50 M3 S700 X10 Y-25;	(Position of tool)
N20 G01 Z-1.5;	(Position of cut)
N25 G01 X4 F100 M8;	(Cutting slat)
N30 G00 Z100 M9;	(Final position of tool)
N35 M30;	(Main programme end)

(*iii*) PROGRAMME FOR CONTOUR MILLING

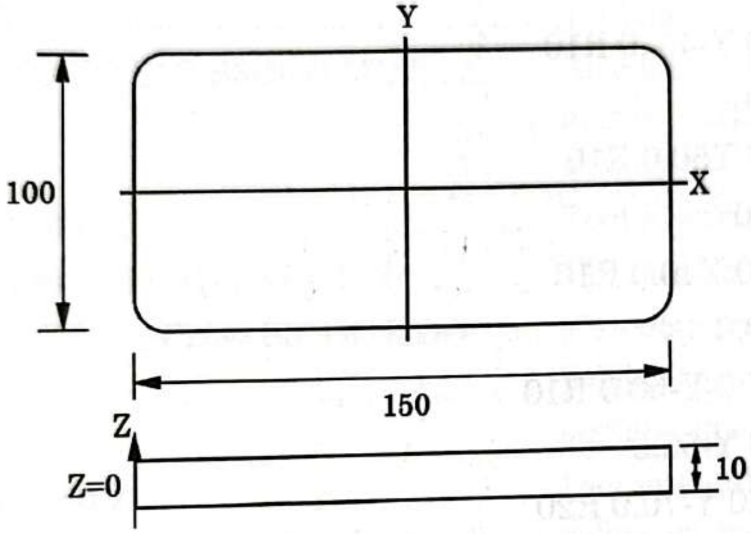


Fig. P-5.3 : Contain Milling

Given tool length offset H01 D

Dia off D01

O1008	Program Number
N010	G90 G54 G80 G17 G40 G49 G21 Previous canned cycle, tool length compensation etc. cancel
N020 T01 M06	Tool change
N030 G90 G00 X20.0 Y-90.0	
N040 G43 Z200.0 H01	Tool length compensation
N050 M03 S200 Z50.0	
N070 M98 P200	Subroutine call
N080 Z-10.0	
N090 M98 P200	Subroutine call
N01100G90 G00	

Z200.0G49	
N0120 M30	
Sub Program	
O200	Program Number
N010 G90 G00 X20.0 Y-90.0	
N20 G42 Y-70.0 D01	
N30 G02 F100.0 X0.0 Y-50.0 R20	
N40 G01 X65.0 Y-50.0	
N50 G03 X75.0 Y-40 .0 R10	
N60 G01 Y40.0	
N70 G03 X65.0 Y50.0 R10	
N80 G01 X-65.0	
N90 G03 X-75.0 Y40.0 R10	
N100 G01 Y-40.0	
N110 G03 X-65.0 Y-50.0 R10	
N120 G01 X0.0 Y-50.0	
N130 G02 X20.0 Y-70.0 R20	
N140 G00 G40 X20.0 Y-90.0	
N150 M99	End of sub program.

(*iv*) PROGRAMME FOR POCKET MILLING

Two types of pocket milling are (*i*) circular pocket (*ii*) Rectangular pocket

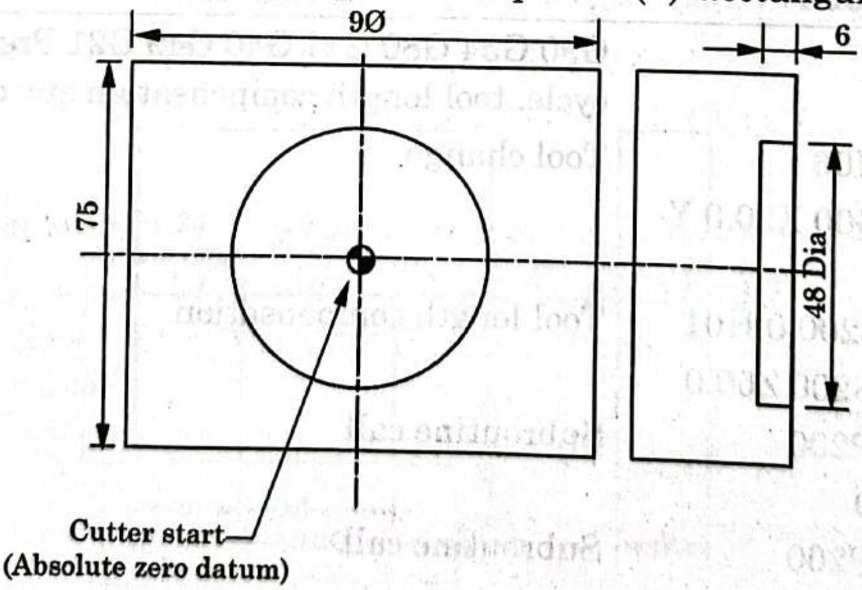


Fig. P-5.4 (*a*) : Circular Pocket Milling

(i) Circular Pocket Milling :

PROGRAM NUMBER ØØØ2-ROUGHING PROGRAM- CIRCULAR POCKET-G17Ø AND G171.	
[BILLET X75 Y9Ø Z3Ø ;	Billet size.
[EDGEMOVE X-37.5 Y-45 ;	Position of datum from the bottom LH corner of billet.
[TOOLDEF T1D6 ZØ;	Tool no. dia. and position.
0 ØØØ2 ;	Program no.
NØØ40 G91 G28 XØ YØ ZØ ;	Metric, reference point.
NØØØ5Ø MØ6 TØ1 ;	Tool no.
NØØ6Ø G9Ø GØØ XØ YØ Z1Ø S3ØØØ MØ3;..........	Absolute, rapid, tool 10mm above surface, spindle speed and start.
NØØ 7Ø GØ1 ZØ F3ØØ;..	Tool to surface of job, feed set.
NØØ 8Ø G17ØRØPØØ3XØYØZ-61ØJØK-24;............	Circular pocket canned cycle.
NØØ9ØG171P75S3ØØØR75F25Ø B35ØØJ2ØØ;........	Circular pocket canned cycle.
NØ 1ØØ GØØ Z25 MØ5;..	Rapid, tool to 25 mm above surface, spindle stop.
NØ1 1Ø G91 G28 XØ YØ ZØ;.......................................	Incremental, return to reference point.
NØ 12Ø M3Ø ;	Program reset.

Definitions for the terms used in the G17Ø and G171 circular pocket canned cycle from program number ØØØ 2 follows :

NØØ8 G17Ø RØ PØ Ø3 XØ YØ Z-6 1Ø JØ K-24 ;

NØØ9Ø G171 P75 S3ØØØ R75 F25Ø B35ØØ J2ØØ ;

For G 17Ø block,

R defines the position of the tool to start cycle i.e. Ø (surface of job).

P defines when P is zero (Ø) the cycle is a roughing cycle.

Q defines the peck increment, in program number ØØØ2, 2pecks each of 3mm.

X defines the pocket centre in X axis (Ø).

Y defines the pocket centre in Y axis (Ø).

Z defines the pocket base (-6mm) from job surface.

I defines the side finish allowance (Ø as this is a roughing cycle only).

J defines the base finish allowance (Ø as this is a roughing cycle only).

K defines the radius of pocket (-24) negative value-cut in CCW direction).

For G171 block,

P defines the cut width percentage.

S defines the roughing spindle speed (S3ØØØ).

R defines the roughing Feed in Z (75).

F defines the roughing feed XY (25Ø).

B defines the finishing spindle speed (35ØØ, not applicable as roughing only).

J defines the finishing feed (2ØØ, not applicable as roughing only).

When setting offsets the value R must be included, R being the radius of the cutter.

The direction of the cutter path is controlled by K, a negative (K-24) value for K means the cutter path is in a CCW direction and if the K value is positive (K+24) the cutterpath is in a CW direction. The Q value is always positive (Q+3).

When the tool has finished cutting the tool retracts 1mm in the Z axis, moves to the centre of the circular pocket at rapid traverse, retracts again in the Z axis.

Program number ØØØ2 is for a two cut roughing cycle.

(b) Rectangular Pocket Milling

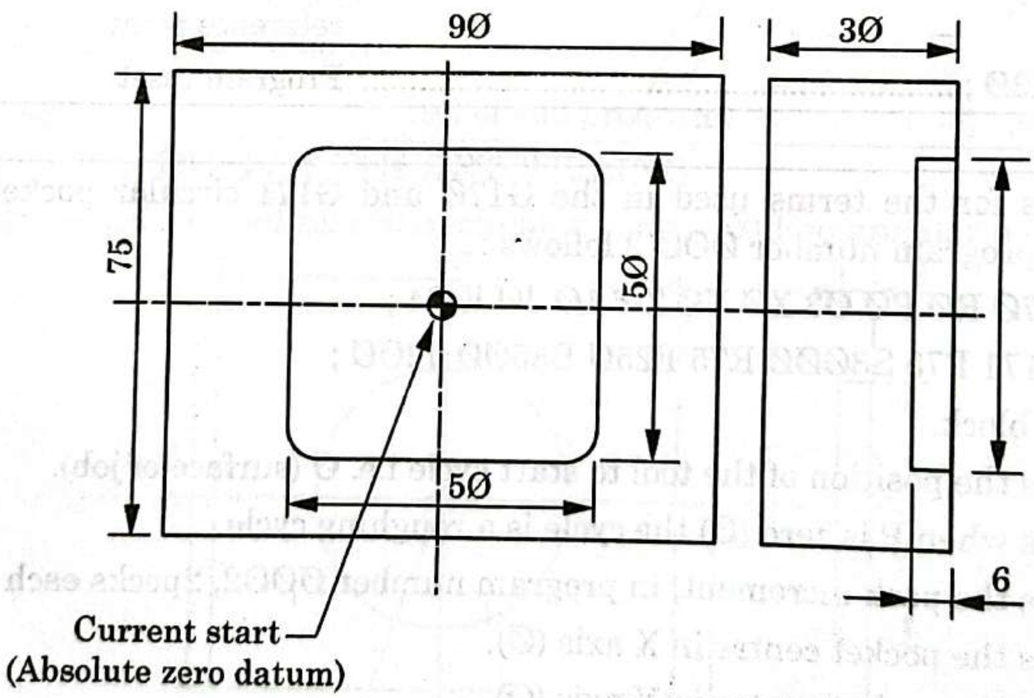


Fig. P-5.4(b) : Rectangular Milling

PROGRAM NUMBER ØØØ-ROUGHING PROGRAM-RECTANGULAR POCKET-G172 AND G173.	
[BILLET X75 Y9Ø Z3 Ø ;	Billet size.
[EDGEMOVE X-37.5 Y-45 ;	Position of datum from the bottom LH corner of billet.
[TOOLDEF T1 D6 ZØ ;	Tool no. dia. and position.
0 ØØØ5 ;	Program no.
NØØ 4Ø G91 G21 G28 XØ ZØ ;	Tool no.
NØØ6Ø GØØ XØ Z1Ø S3ØØØ MØ3 ;	Absolute, rapid, tool 1Ømm above surface, spindle speed and start.
NØØ8ØG172l-5ØKØPØQ3RØX-25Y-25Z-6;...........	Rectangular pocket cycle.
NØØ9ØG173lØKØP75T1S3ØØR75F25ØB35ØØJ2ØØZ5;	Rectangular pocket cycle.
NØ 1ØØ GØØ Z25 MØ5;..	Rapid, tool to 25mm above surface, spindle stop.
NØ 11Ø G91 G28 XØ YØ ZØ;.................................	Incremental, return to reference point.
NØ 12Ø M3Ø ;	Program reset.

Definitions for the terms used in the G172 and G173 rectangular pocket canned cycle from program number ØØØ5 follows :

NØØ8Ø G172 l-5Ø KØ PØ Q3 RØ X-25 Y-25 Z-6 ;

NØØ9Ø G173 lØ KØ P75 T1 S3ØØ R75 F25Ø B35ØØ J2ØØ Z5;

For G172 block,

- I defines the pocket X length (-5Ø).
- J defines the pocket Y length (-5Ø)
- K defines the radius of corner roundness (not applicable to Denford software).
- P defines that Ø = roughing cycle.
- Q defines the pocket Z increment (peck increments in above cycle 2-3mm pecks).
- R defines the Absolute Z 'R' point.
- X defines the pocket corner X (Absolute position relative to the X datum position).

Y defines the pocket corner Y (Absolute position relative to the Y datum position).

Z defines the absolute Z base of pocket (-6, i.e., a depth of 6mm).

For G173 block,

I defines the pocket side finish (Ø as this is a roughing cycle).

K defines the pocket base finish (Ø as this is a roughing cycle).

P defines the cut width percentage (75% of tool dia.).

T defines the pocket tool (too 1).

S defines the spindle speed for roughing (3ØØØ rpm).

R defines the roughing feed for Z (75).

F defines the roughing feed X and Y (25Ø).

B defines the finishing spindle speed (35ØØ rpm)

J defines the finishing feed (2ØØ).

Z defines the safety Z (5mm above 'R' point).

Program number ØØØ5 is for a two cut roughing cycle.

PRACTICAL NO. - 6

AIM : *Preparation of Work instructions for machine operator*.

Theory : A machine operator is a person who operate and control the machine. He controls the quality of the product and quantity to be manufactured. Due to regular change of duties it is not possible to give instructions to the every machine operator. So a common type of instructions should be prepared, which will implement on every operator. There are many types of machine tools are used in production department. Here, we are considering only the two types of machine tools:

(*i*) Lathe machines

(*ii*) Milling machine

(*a*) INSTRUCTIONS ABOUT THE LATHE : The lathe is one of the most dangerous machines in the shop. The rotating chuck has a great deal of kinetic energy and can easily catch clothing, fingers, etc. To minimize possibility of injury the user is required to follow the appropriate safety rules and guidelines. The principal hazard for the lathe operator is potential injury of fingers, hands, and arms as a result of a contact with the point of operation, revolving spindle, or other moving machine elements. Objects that are thrown out of the working area due to the high kinetic energy of the rotating parts can also pose a hazard. Primary motion is a rotation of the spindle and part. The secondary motion is a worm gear rotation and linear motion of the cutter.

1. Safety glasses must be worn at all times in the machine shop area whether working or not!
2. Loose clothing, ties, long sleeves, rings, large hoop earrings and wrist watches may become entangled in revolving lathe parts. Remove these items before working.
3. Never turn away from the lathe while it is running. Always keep your eyes and your attention on the machine and the part you are turning on it.
4. Never leave the chuck wrench in the chuck socket at any time. If someone turns on the power, the wrench can be thrown out with high velocity. Remove the chuck key from the chuck immediately after using it.
5. Do not start the lathe if there are any operating knobs or levers that you don't understand. If you need help or advice just ask the shop manager.
6. Make sure that chuck, drive plate, or faceplate is securely tightened in the lathe spindle. If you don't check this the work can be thrown out from the machine!
7. When installing or removing the chuck, drive plate, or faceplate make sure the machine's power is off! Also use a wooden plate to hold the chuck until you can install it onto the nose of the lathe. Always get help because most lathe chucks are heavy and can crush you hand against the bed of the lathe.
8. Turn the chuck or faceplate through by hand before turning on the power; to be sure there are no binding or clearance problems.
9. When clamping work to the faceplate, be sure to balance it. This will prevent vibration and the possibility of damaged or poorly machined work. Spin the faceplate in neutral and readjust if grossly out of balance.
10. Keep clear of the revolving lead screw. Always keep it disconnected unless you are actually using it.
11. Move the tool bit to a safe distance away from the collet or chuck when inserting or removing work.
12. When setting up the tool holder, place it to the left of the compound slide to prevent the slide from running into and being struck by the lathe chuck or spindle attachments.
13. Don't run the machine faster than the proper cutting speed – consult a speed and feed table to determine the best speed.
14. Always clamp the tool bits as short as possible in the tool holder to prevent it from breaking or chattering.

15. Be sure that the tool bit is sharp and has the proper clearance. Ask for assistance if you are not sure how to make the adjustments.
16. Be sure that cutting tool is positioned on the centerline of your work to prevent parts from climbing over the tool or cutting above the center and dragging.
17. If the work is being turned between the centers, make sure that the proper adjustment is made between centers and that the tail stock is locked in place. Also double check the faceplate and drive dog to make sure they are secure.
18. Always remove the tool holder and tool post from the compound rest before filing or polishing work on the lathe. If any filing is done on work revolving in the lathe, file left handed to prevent slipping into the chuck. Never use a file without a handle.
19. Never put fingers in the arbor hole while the head stock spindle is revolving. Wipe out the arbor hold only when machine has reached full stop.
20. Reversing directional rotation of the headstock spindle should only be done when you are power tapping and you need to reverse thread the tap out of the hole.
21. Never try to take work from between the centers until the lathe comes to a complete stop.
22. Do not cut completely through when working between centers.
23. Stop the machine and clean you part off before taking measurements.
24. Before cleaning the lathe remove the tools from the tool post and tailstock.
25. Disengage the power feed when you are feeding close to a shoulder to prevent the tool bit from digging into the workpiece.
26. Plan to spend at least 15 minutes on cleaning around your work shop area. ALWAYS leave the machines and work area in better condition than you found it.
27. Failing to clean up will lead to a badge punch and potential suspension from machine shop usage.

(*b*) INSTRUCTION ABOUT THE MILLING MACHINE : The milling machine, like any other machine shop tool, is not dangerous if certain safeguards are installed and if the operator uses safe operating practices.

The principle hazard to the milling machine operator is that of injury to the arms, hands, or fingers by contact with the cutter. Hands are frequently cut when they are used to brush away chips from various parts of the machine. Eye injury can result from not wearing safety glasses.

Observe the following precautions

1. Safety glasses are to be worn when operating the milling machine.
2. Milling machine operators should not wear gloves, loose or torn clothing.
3. Before inserting the collet or milling cutter into the spindle, ensure that both the collect and spindle hole are clean and free from nicks and chips.
4. To avoid striking a hammer on the cutter while setting up, the setup should be done as far away from the cutter as possible.
5. The floor about the milling machine should be kept free of oil and material that might cause slipping or stumbling.
6. While around a milling machine do not distract the operator's attention from his/her work while the machine is making a cut, this is decidedly unsafe and will not be allowed.
7. When a student has finished an operation, or before they leave their machine for any reason, they should shut off the power and make sure the machine has stopped running.
8. You should always be very alert and careful when operating the milling machine. It is considered one of the more dangerous machines in the shop.
9. Never try to clean the chips from the milling machine while it is cutting. The brush, or rag, that you use is liable to be caught in the cutter.
10. Never brush chips from the milling machine with your fingers, even when the machine is not cutting a part. The sharp edges of the chips may cut you.
11. It is wise to keep the cutter fluid used on the milling machine out of open cuts or sores. It may cause an infection.
12. Keep clear of the revolving lead screws or moving handles. If your clothing is drawn into the machine you may get hurt.
13. Be sure that your work is clamped tightly on the milling machine table or in the vise. With the power of the machine, work moving under the pressure of a cut will break the endmill before stalling the machine and the broken endmill may hit you.
14. Always use the hand feeds when you bring the work up to the cutter. Using the power feeds when the machine is adjusted for too deep a cut may break the endmill and throw the work off the machine.
15. For rough cutting feed the work against the revolving cutter (convention milling). By doing this, there is less danger of breaking an endmill or having work thrown from the machine.

16. Climb milling is only used for machining a finish pass on the work. It should be no more than. 010 in depth and a constant even feed should be used.
17. Do not attempt repairs or adjustments that you are not qualified and/or authorized to perform.

PRACTICAL NO. 7

AIM : *Preparation of Preventive maintenance schedule for CNC machine.*

Theory : Preventive maintenance is sometimes termed as **"Planned maintenance"** or **"Systematic plant maintenance"** etc. It is an extremely important function for the reduction of maintenance cost and to keep the good operational condition of equipment and hence increases the reliability. Preventive maintenance aims to locate the sources of trouble and to remove them before the breakdown occurs. Thus it is based on the principle "Prevention is better than cure". Scheduled maintenance is always economical than unscheduled maintenance, as we all know that, "a stitch in time saves nine".

FUNCTIONS OR ELEMENTS OF PREVENTIVE MAINTENANCE

(*i*) Inspection
(*ii*) Servicing including cleaning, cooling and lubrication
(*iii*) Planning and Scheduling
(*iv*) Records and analysis
(*v*) Training to maintenance staff.
(*vi*) Storage of spare parts.

PREVENTIVE MAINTENANCE CHECK : Check ups is an essential function of the preventive maintenance programme. Crew kept for this purposes should be well trained. These crews carry out both the external and internal checks. External checks means to watch for and detect defects from abnormal sound, vibration, heat, smoke etc. when machine is in operation ; while internal checks means inspection of internal parts, such as gears, bushes, bearings, tolerances in the parts etc. during the period when the machine is under preplanned shutdowns.

PROCEDURE FOR MAINTENANCE CHECK

The procedure of preventive maintenance check is shown in fig. P-7.1

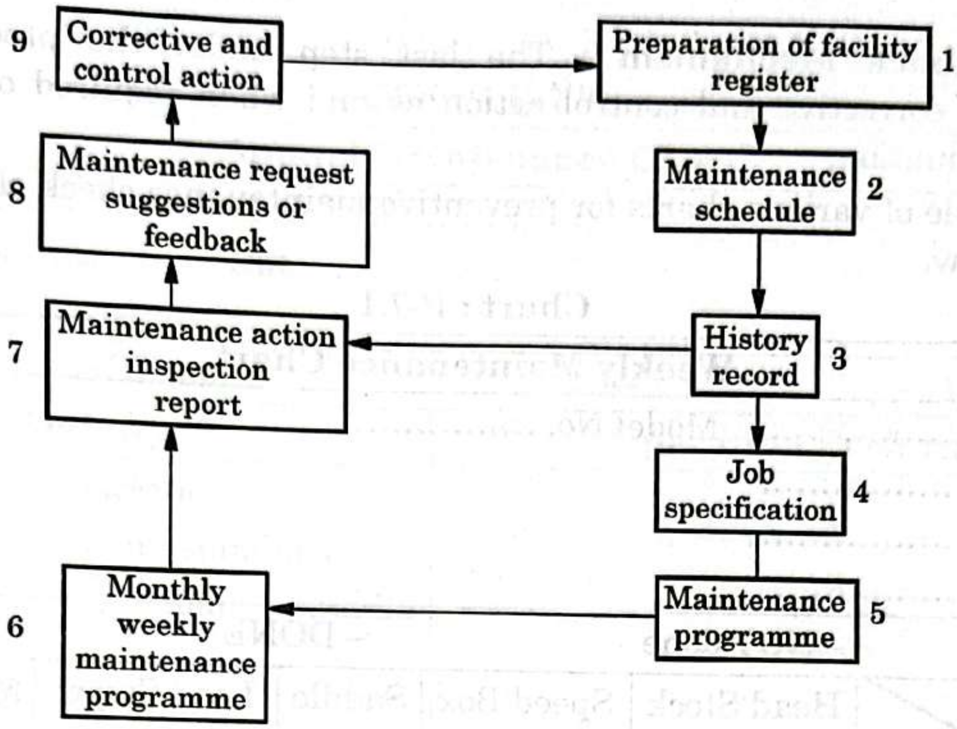


Fig. P-7.1 : Procedure for preventive

1. **Preparing Facility Register :** The facility register defined what is to be maintained. It gives the complete details of all the items and facilities which are to be maintained in the near future.

2. **Maintenance Schedule :** It gives the information regarding the method, time and place of maintenance work.

3. **History Card :** It records the frequency of occurrence of different types of faults, the rate of wear of different components etc.

4. **Job Specification :** It provides the information regarding the maintenance work to be done. These details are generally prepared from maintenance schedule already prepared.

5. **Maintenance Programme :** It is a sequential list which allocates specific maintenance work to a specified period.

6. **Weekly / Monthly Programme :** According to the requirements and importance of the machined maintenance frequency is decided and the weekly / monthly maintenance programme is prepared.

7. **Inspection Report :** It provides the information about the inspection which were performed in the past.

8. **Maintenance Request :** It is simply a document or various maintenance suggestions and recommendations given by the inspection report.

9. Feedback Mechanism : The last step under the procedure is the application of corrective and control action as and when required on the basis of feedback information.

The sample of various charts for preventive maintenance check of machine tools are given below.

Chart : P-7.1

Weekly Maintenance Chart					
Machine .... Model No. .... Deptt. .... Date .... Operator					
TICK (√) – NOT done		– DONE			– Pending
Activity / Parts	Head Stock	Speed Box	Saddle	Lead Screw	Motor Bearing
1. Coolant Check					
2. Lubrication					
3. Filter check					

Chart : P-7.2

Monthly Maintenance Chart	
Machine .... Model No. .... Deptt. .... Date .... Operator	
TICK – NOT done – DONE – Pending	
Activity	**Operation Performed**
1. Balt Change 2. Temperature Check 3. Bearing Condition 4. Coolant Pump 5. Movement of Carriage and cross-slide	

Chart : P-7.3

Annual Maintenance Chart	
Machine .... Model No. .... Deptt. .... Date .... Operator	
TICK – NOT done – DONE – Pending	
Activity	**Operation Performed**
1. Levelling of machine 2. Alignment of main spindle axis 3. Adjustment of main spindle bearing 4. Transmission system	

PRACTICAL NO. 8

Aim : *Demonstration through industrial visit for awareness of actual working of FMS in production.*

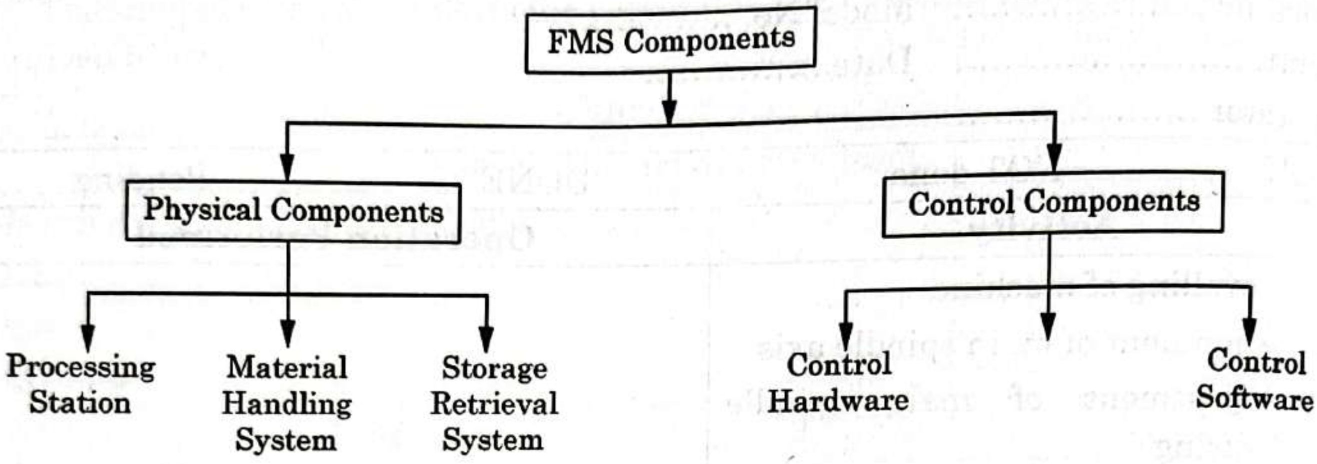
Theory : Before demonstration through industrial visit it is necessary to understand what is FMS (Flexible manufacturing system) ?

Flexible Manufacturing System (FMS) : "Flexible manufacturing system is a system dealing with group of machining stations (NC, CNC machine tools) and automated material handling system using computer controlled machines."

The main distinguishing feature of a flexible manufacturing system from conventional manufacturing system is **flexibility.** Flexible manufacturing system is a group of CNC machine tools integrated with automated material handling system to process a variety of different types of parts at various workstations.

FMS is different from an automated production line because it can manufacture more than one product types at the same time. At any moment, each machine in the system may be processing a different part type. FMS consists of several machine tools along with part and tool handling devices such as industrial robots, inspection machines. These are arranged in such a way so that it can handle any family of parts for which it has been designed and developed. It covers broad areas of manufacturing activities such as machining, fabricating, sheet metal, welding and assembly.

Components of Flexible Manufacturing System : It consists of mainly two types of components refer fig. P-8.1.



PROCEDURE FOR DEMONSTRATION THROUGH VISIT FOR AWARENESS

The procedure is as follows :

1. Select the industry (where FMS is implemented)
2. Visit properly the industry and collect the data and informations and fill in the prescribed format e.g. refer table P-8.1.

Table P-8.1

Name of Industry .... Name of Institution .... Incharge of tour /visit..........................			Date of Visit.................................. Trade/Displine .... Name of Demonstrator Officer			
Sr. No.	**Activity/Event**	**Types**	**Availability**		**Working/In use**	
			Yes	No	Yes	No
			(√)	(×)	(√)	(×)
1.	**Flexible faunufacturing system**	(*i*) **Flexible manufacturing cell**	☐	☐	☐	☐
		(*ii*) **Flexible transfer line**	☐	☐	☐	☐
		(*iii*) **Flexible machining system**	☐	☐	☐	☐

2.	Flexible manufacturing system workstation	(*i*) Machine centers	☐	☐	☐	☐
		(*ii*) Milling and turning units	☐	☐	☐	☐
		(*iii*) Sheet Metal station	☐	☐	☐	☐
		(*iv*) Assemble workstation	☐	☐	☐	☐
		(*v*) Other specific workstation	☐	☐	☐	☐
3.	Material Handling Equipments	(*i*) Automated guided vehicles	☐	☐	☐	☐
		(*ii*) Conveyor	☐	☐	☐	☐
		(*iii*) Robot	☐	☐	☐	☐
4.	FMS layout	(*i*) Single and Double line machine layout	☐	☐	☐	☐
		(*ii*) Loop layout	☐	☐	☐	☐
		(*iii*) Ladder layout	☐	☐	☐	☐
		(*iv*) Circular Machine layout	☐	☐	☐	☐
		(*v*) Open field layout	☐	☐	☐	☐
5.	Departments	(*i*) Production /manufacturing	☐	☐	☐	☐
		(*ii*) Inspection	☐	☐	☐	☐
		(*iii*) Assembly	☐	☐	☐	☐

On the above said way the information can be collected. It depends on the type of industry visited.

After visited the industry and observed the activities, advantages, limitations and problems in implements FMS should be prepared.

Advantages :

1.
2.
3.
4.
5.

Limitation :

1.
2.
3.
4.
5.

Problems in implementing FMS :

1.
2.
3.
4.

On the above said facts, students may submit a brief report to the laboratory incharge.

1.
2.
3.
4.
5.